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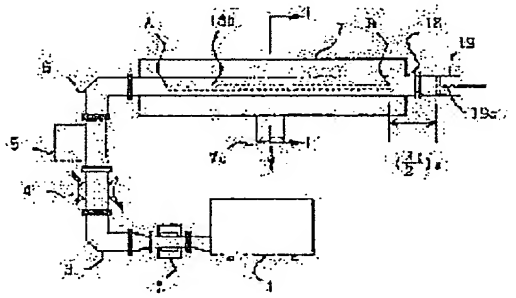
(54) PLASMA TREATMENT DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a plasma treatment device capable of performing uniform and quick treatment over a wide area on a material to be treated and improving efficient use of microwave power.
SOLUTION: A device has a plasma chamber 7 provided with a slender window (7b) on the side wall to arrange a material to be treated inside the window, a plasma chamber joined rectangular wave guide 18 provided with a slot 18b in the (E) face as the side face parallel to a field vector to be extended to the tube-axial direction and arranged with the tube-axial direction corresponding to the longitudinal direction of the window in the condition that the slot is opposed to the window and a microwave power supply 1 to supply microwaves to the rectangular wave guide. A terminator 19 with a short-circuit board 19c is provided at the terminal of the rectangular wave guide 18. The longitudinal length of the slot 18b is set to be a common multiple of the half length of the in-tube wavelength λg of a microwave in the rectangular wave guide 18 and the half length of the free space wavelength of the microwave. A length from the end of the slot 18b to the short-circuit board 19c is set to be n/2 of the in-tube wavelength λg (n: an integer).



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CLAIMS

[Claim(s)]
[Claim 1] The plasma room where it has a long and slender window part on a side attachment wall, and a processed material is arranged inside said window part, The rectangular waveguide for plasma room association arranged in the condition of having the slot extended in the direction of a tube axis to the Eth page which is side faces parallel to the direction of an electric field vector, and having made the direction of a tube axis in agreement with the longitudinal direction of said window part, and having made said slot countering said window part, In the plasma treatment equipment which equips said rectangular waveguide with the microwave power source which supplies microwave, and is made to emit microwave to said plasma room through said slot from said rectangular waveguide The termination machine which has a shorting bar to the termination of said rectangular waveguide is formed, and the die length of the longitudinal direction of said slot is guide wave length lambdag of the microwave in said rectangular waveguide. The die length of 1/2, It is set as a common multiple with 1/2 of the die length of the free space wave length of microwave, and the die length of the edge of said slot and a shorting bar is said guide wave length lambdag (n (n/2): integer). Set-up plasma treatment equipment.
[Claim 2] The plasma room where it has a long and slender window part on a side attachment wall, and a processed material is arranged inside said window part, The rectangular waveguide for plasma room association arranged in the condition of having the slot extended in the direction of a tube axis to the Eth page which is side faces parallel to the direction of an electric field vector, and having made the direction of a tube axis in agreement with the longitudinal direction of said window part, and having made said slot countering said window part, In the plasma treatment equipment which equips said rectangular waveguide with the microwave power source which supplies microwave, and is made to emit microwave to said plasma room through said slot from said rectangular waveguide The termination machine which has a shorting bar to the termination of said rectangular waveguide is formed, and the die length of the longitudinal direction of said slot is guide wave length lambdag of the microwave in said rectangular waveguide. The die length of 1/2, It is set as a common multiple with 1/2 of the die length of the free space wave length of microwave. The die length of the edge of said slot and a shorting bar is said guide wave length lambdag (n (n/2): integer). It is set up. It is said guide wave length lambdag to the direction of a tube axis of said rectangular waveguide by turns in said slots which form said at least two rectangular waveguides which established said slot, and adjoin each other in parallel in said rectangular waveguides. Plasma treatment equipment which could shift (2n-1) / 4 (n: integer), and has been arranged.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the plasma treatment equipment for performing processing of thin film formation, surface treatment, etching, etc. at homogeneity and a high speed to the processed material of a large area.
[0002]
[Description of the Prior Art] In recent years, the plasma equipment which used microwave for a semi-conductor and etching in the production process of LCD, ashing, CVD, etc. is used. Drawing 7 is the conventional plasma treatment equipment whole block diagram shown in JP,5-335095,A, drawing 8 is the I-I line sectional view of drawing 7 , and drawing 9 is the T-T line sectional view of drawing 8 . This equipment equips the Eth page with the rectangular waveguide 8 for mounting beam plasma room association, and the terminating set 9 for the microwave power source 1, an isolator 2, the corner rectangular waveguide 3, a directional coupler 4, the impedance matching box 5, the corner rectangular waveguide 6, the rectangular parallelepiped-like plasma room 7, and the plasma room, as shown in drawing 7 . In addition, the Eth page is side faces parallel to the direction of the electric field vector in a rectangular waveguide.
[0003] The plasma room 7 is vacuum ********** by the microwave transparency aperture 11 in which window part 7b of the shape of a long and slender rectangle extended along the direction of a tube axis of a rectangular waveguide 8 to side-attachment-wall 7a by the side of the rectangular waveguide 8 for association is prepared and which this window part 7b becomes from a quartz-glass plate as shown in drawing 8 . Moreover, this exhaust port is connected to the vacuum pump which is not illustrated by preparing exhaust-port 7c in the plasma room 7, and one wall of the plasma room 7 is made to penetrate airtightly, and the process gas installation pipe 12 is attached. Into this plasma room 7, opposite arrangement of the roller 14 around which the sheet-like processed material 13 was wound, and the rolling-up roller 15 which rolls round the processed material which processing ended is carried out, and opposite arrangement of the processed material 13 is carried out at window part 7b.
[0004] Slot 8b extended in the direction of a tube axis is prepared in Eth page 8a, and this rectangular waveguide 8 and the plasma room 7 are electrically connected to the rectangular waveguide 8 for association in the condition of having made slot 8b countering window part 7b of the plasma room 7. Although slot 8b has die length almost equal to the longitudinal direction of window part 7b of the plasma room 7, the width-of-face dimension is set up smaller than the width-of-face dimension of window part 7b. Moreover, the die length of a longitudinal direction is the free space wave length lambda 0 of microwave, as shown in JP,8-138889,A. It is common to be set as the integral multiple of 1/2.
[0005] The termination machine 9 consists of microwave absorbers which absorb the excessive microwave which was not supplied to the plasma room 7 side, and water is used for it as a microwave absorber. The water introduced from inlet 9a is made to absorb the excessive microwave which was not spread in the plasma room 7, and the water heated by microwave is made to drain from exhaust port 9b.
[0006] In performing plasma treatment using the above-mentioned plasma treatment equipment,

after setting a processed material 13 in the plasma room 7, it changes the inside of the plasma room 7 into a high vacuum condition. After that, from the process gas installation pipe 12, in the plasma room 7, predetermined process gas is supplied until the plasma interior of a room becomes a predetermined pressure. If microwave is supplied to the rectangular waveguide 8 for plasma room association from the microwave power source 1 through an isolator 2, the corner rectangular waveguide 3, a directional coupler 4, an impedance matching box 5, and the corner rectangular waveguide 6 in this condition, the microwave which advanced into the rectangular waveguide 8 for association will be emitted from slot 8b, will be spread in the plasma room 7 through window part 7b of the plasma room 7, will plasma-ize the process gas of the plasma interior of a room, and will generate the band-like plasma. A large area can be made to process continuously by rolling round a processed material 13 with a roller 15, and moving this plasma, irradiating a processed material 13.

[0007] Since a field arises to the space between window part 7b of the plasma room 7, and a processed material 13 by having formed the electromagnet in the periphery of the rectangular waveguide 8 for association as a field generating means 10 especially, ionization of reactant gas and the frequency of excitation can be raised, and the plasma consistency irradiated by the processed material is raised by this field. Moreover, since the above-mentioned field is the divergence field which goes to the center section of the plasma room from a window part, the plasma can be made to irradiate a processed material 13 efficiently.

[0008]

[Problem(s) to be Solved by the Invention] It originates in spreading aslant with conventional plasma treatment equipment, microwave repeating an echo with the internal side attachment wall of the rectangular waveguide 8 for association. The microwave emitted to the plasma room 7 from slot 8b The microwave W1 of drawing 9 , and W2 And W3 It becomes the propagation mode which inclined toward one side in the plasma room 7 so that it may be shown. Consequently, the microwave field strength emitted to the plasma room 7 from slot 8b of die-length A'B' had the problem that covered the longitudinal direction of the plasma room 7 and it did not become homogeneity, as shown in drawing 10 .

[0009] Moreover, in spite of constituting the termination machine 9 from a microwave absorber, as San-ya of the standing wave by the reflected wave produced by establishing a slot exists, consequently microwave field strength is shown in drawing 10 , it is guide wave length lambdao of microwave. It is uneven distribution with San-ya for every 1/2. Therefore, distribution of the plasma to generate serves as an ununiformity and the problem was in the homogeneity processing covering a large area of a processed material 13.

[0010] Furthermore, since the power which was not emitted to the plasma room 7 from slot 8b among the microwave power inputted into the rectangular waveguide 8 for plasma room association was consumed through the rectangular waveguide 8 by the microwave absorber in the termination machine 9 and became power loss altogether, it had the trouble that the utilization ratio of power worsened and the plasma consistency generated became low.

[0011] The object of this invention can cover a large area to a processed material, can be processed at homogeneity and a high speed, and is to offer the plasma treatment equipment which moreover raised the utilization ratio of microwave power.

[0012]

[Means for Solving the Problem] The plasma room where this invention has a long and slender window part on a side attachment wall, and a processed material is arranged inside a window part, The rectangular waveguide for plasma room association arranged in the condition of having the slot extended in the direction of a tube axis to the Eth page which is side faces parallel to the direction of an electric field vector, and having made the direction of a tube axis in agreement with the longitudinal direction of a window part, and having made the slot countering a window part, A rectangular waveguide is equipped with the microwave power source which supplies microwave, and it is involved in the plasma treatment equipment made to emit microwave to a plasma room through a slot from a rectangular waveguide.

[0013] Invention according to claim 1 forms the termination machine which has a shorting bar to the termination of a rectangular waveguide, and is guide wave length lambdag of the microwave

in a rectangular waveguide about the die length of the longitudinal direction of a slot. The die length of 1/2, It is set as a common multiple with 1/2 of the die length of the free space wave length of microwave, and is guide wave length lambdag about the die length of the edge of a slot, and a shorting bar (n (n/2): integer). It sets up.
[0014] It is [0015] which is good also as for the radiant efficiency of the microwave from a slot to open space, becomes dominant [the field strength moreover emitted / the guide wave length of microwave], and is not distorted or is not carried out in invention of above-mentioned claim 1. [that the distribution inclines extremely spatially] Invention according to claim 2 forms the termination machine which has a shorting bar to the termination of a rectangular waveguide, and is guide wave length lambdag of the microwave in a rectangular waveguide about the die length of the longitudinal direction of a slot. The die length of 1/2, It is set as a common multiple with 1/2 of the die length of the free space wave length of microwave. The die length of the edge of a slot, and a shorting bar Guide wave length lambdag (n (n/2): integer) Set up and at least two rectangular waveguides which established the slot are formed. It is guide wave length lambdag to the direction of a tube axis of a rectangular waveguide by turns in the slots which adjoin each other in parallel in rectangular waveguides. It can shift (2n-1) / 4 (n: integer), and arranges.
[0016] In invention of above-mentioned claim 2, although the microwave field strength emitted to a plasma room from each slot has San-ya corresponding to 1/2 of the guide wave length of microwave, since the part where field strength is strong, and a weak part pile up, respectively, the magnitude of the strength of field strength is greatly eased rather than the microwave field strength emitted from each slot.
[0017]
[Embodiment of the Invention]
<Operation gestalt of ** 1st> drawing 1 is the whole block diagram showing the 1st operation gestalt of the plasma treatment equipment concerning this invention. In this drawing, a corner rectangular waveguide and 4 are constituted by a microwave power source and 2 like drawing 7 with which an isolator, and 3 and 6 are plasma rooms and 1 indicated [six] a directional coupler and 5 to be for an impedance matching box and 7 in the conventional example. The rectangular waveguide for plasma room association with which 18 prepared slot 18b, and 19 are the termination machines equipped with shorting-bar 19c. In addition, since it is the same as that of drawing 8 shown in the conventional example, the sectional view of the plasma room 7 is omitted.
[0018] For this operation gestalt, the die length of the longitudinal direction of a slot is guide wave length lambdag of the microwave in a rectangular waveguide 18. The die length of 1/2, and free space wave length lambda 0 of microwave It is set as a common multiple with the die length of 1/2.
[0019] Since this operation gestalt is used as the termination machine 19 equipped with shorting-bar 19c instead of the termination machine which consisted of microwave absorbers shown in the conventional example again, the microwave introduced into the rectangular waveguide 18 for association can be efficiently supplied to the plasma room 7 by adjusting suitably this shorting bar and impedance matching box 5.
[0020] In this operation gestalt, if microwave is supplied to the rectangular waveguide 18 for association, surface current as shown in the wall of this rectangular waveguide 18 at drawing 2 will flow. This surface current originates in the standing wave of microwave, and is guide wave length lambdag of the microwave in a rectangular waveguide. It has the strength corresponding to 1/2. Then, if opening of the slot extended in the direction of a tube axis is carried out to the Eth page of a rectangular waveguide, the flow of surface current will be cut, induction of the charge will be carried out to the vertical side of the opening, and microwave will be emitted to space from a slot. Since the field strength in the ends of the longitudinal direction of the slot of the microwave emitted from a slot has short-circuited the both ends, it is zero. Therefore, the die length of the longitudinal direction of a slot is guide wave length lambdag of microwave. It is desirable to consider as the integral multiple of 1/2.
[0021] On the other hand, the microwave emitted to space from the slot is free space wave length lambda 0. Since the inside of space is spread, at the former, the die length of the

longitudinal direction of a slot is the free space wave length lambda 0 of microwave. It considers as the integral multiple of 1/2.
[0022] When determining the die length and the location of a longitudinal direction of a slot, in this invention about length It is set as a common multiple as mentioned above. About a location About the die length of the edge B of slot 18b, and shorting-bar 19c, it is guide wave length lambdag of microwave (n (n/2): integer). If it sets up The field strength to which the radiant efficiency of the microwave from a slot to open space is also good for, and is moreover emitted is guide wave length lambdag of microwave. It became dominant and found out, and the distribution not being distorted or not carrying out it. [inclining extremely spatially]
[0023] Here, when the example of the die length of the longitudinal direction of a slot is shown, when the frequency of microwave is 2.45GHz, it is free space wave length lambda 0, using WR-430 inside diameter 109mmx55mm waveguide as a rectangular waveguide 18 for association. 122mm and guide wave length lambdag It is set to 148mm and about 370mm, about 740mm, about 1110 etc.mm, etc. can be considered as 1/2 of common multiples of each wavelength. Although these values do not serve as both common multiple strictly, they do not affect field strength at all.
[0024] In this operation gestalt, as shown in drawing 3 , the microwave field strength emitted to the plasma room 7 from the slot of die length AB Guide wave length lambdag of microwave Although it has San-ya for every 1/2, the peak value of San-ya serves as distribution which gathered almost uniformly. Power of the microwave emitted to a plasma room can be mostly made into homogeneity along with the longitudinal direction of the window part of a plasma room, a long field can be covered and a plasma consistency can be mostly made into homogeneity.
[0025] <Operation gestalt of ** 2nd> drawing 4 is the whole block diagram showing the 2nd operation gestalt of the plasma treatment equipment concerning this invention, and drawing 5 is the I-I line sectional view of drawing 4 . In drawing 4 , corner rectangular waveguide, 4, and 4' is constituted by microwave power-source, 2, and 2' like drawing 7 with which isolator, 3, 3', 6, and 6' is a plasma room, and 1 and 1' indicated ['] directional coupler, 5, and 5' to be for an impedance matching box and 7 in the conventional example. Rectangular waveguide [with which 18 and 18' prepared slot 18b and 18b', respectively] for plasma room association, 19, and 19' is the termination machine equipped with shorting-bar 19c and 19c', respectively, and is constituted like drawing 1 which shows the 1st operation gestalt. In addition, in drawing 5 , the same sign is given to the same component as drawing 8 shown in the conventional example, and explanation is omitted.
[0026] This operation gestalt prepares two rectangular waveguides 18 for plasma room association and 18' which established the slot by this invention, and the termination machine 19 and 19' are connected to the termination of this rectangular waveguide 18 for association, and 18', respectively.
[0027] Slot 18b to which the rectangular waveguide 18 for association and 18' are extended in the direction of a tube axis to the Eth page 18a and 18a', and 18b' are prepared, respectively. It is arranged at proper spacing at parallel, and this slot 18b and 18b' is guide wave length lambdag of microwave to the direction of a tube axis. It can shift (2n-1) / 4 (n: integer), and is arranged. Moreover, the microwave power source 1, 1', an isolator 2, 2', the corner rectangular waveguide 3, 3', 6, 6', the power monitor 4, 4', an impedance matching box 5, and 5' are symmetrically prepared in a rectangular waveguide 18 and 18' to the I-I line, respectively.
[0028] In this operation gestalt, when microwave was supplied to the rectangular waveguide 18 for association, and 18' from the microwave power source 1 and 1', respectively, as each slot 18b and microwave field strength emitted from 18b' were **3**(ed) Guide wave length lambdag of microwave Since it becomes distribution with San-ya for every 1/2, two microwave field strength is compounded by the ability shifting (2n-1) / [of guide wave length lambdag of microwave] 4 (n: integer) so that the part where field strength is strong, and a weak part may pile up, respectively.
[0029] The die length which can shift slot 18b and 18b' mutually is lambda(1/4) g preferably. Or (3/4) lambdag It is desirable. If it can shift more than it, distribution of the microwave field strength only by one slot will become large. That is, at the both ends of the longitudinal direction

of a slot, it becomes distribution of microwave field strength with strength, without compounding microwave.

[0030] In this operation gestalt, as the microwave field strength emitted to a plasma room from the slot of die-length CD shows as the continuous line of drawing 6 , the whole longitudinal direction of a slot is covered and homogeneity improves. In addition, the dotted line of drawing 6 shows distribution of each slot 18b and the microwave field strength emitted from 18b'.

[0031] With the 2nd above-mentioned operation gestalt, although two rectangular waveguides 18 for association and 18' were prepared, three or more are sufficient, the slots which adjoin each other in that case can be {(2n-1) /4} lambdag Shifted by turns (n: integer), and they are arranged. Moreover, the rectangular waveguide 18 for association and 18' may be arranged so that both the propagation directions of the microwave within the rectangular waveguide for association may serve as the same direction.

[0032]

[Effect of the Invention] As mentioned above, since according to invention of claim 1 power of the microwave emitted to a plasma room can be mostly made into homogeneity along with the longitudinal direction of the window part of a plasma room and the utilization ratio of microwave power improves, a long field can be covered, the consistency of the plasma generated can be made into homogeneity, and, moreover, the consistency of the plasma can be raised.

[0033] Since according to invention of claim 2 power of the microwave emitted to a plasma room can be further made into homogeneity along with the longitudinal direction of the window part of a plasma room and the utilization ratio of microwave power improves, a long field can be covered, the consistency of the plasma generated can be further made into homogeneity, and, moreover, the consistency of the plasma can be raised.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the whole block diagram showing the 1st operation gestalt of the plasma treatment equipment concerning this invention.
[Drawing 2] It is drawing having shown the surface current which flows the wall of the rectangular waveguide for association.
[Drawing 3] It is drawing showing the microwave field strength to the die length of the slot by the 1st operation gestalt.
[Drawing 4] It is the whole block diagram showing the 2nd operation gestalt of the plasma treatment equipment concerning this invention.
[Drawing 5] It is the I-I line sectional view of drawing 4 .
[Drawing 6] It is drawing showing the microwave field strength to the die length of the slot by the 2nd operation gestalt.
[Drawing 7] It is the conventional plasma treatment equipment whole block diagram.
[Drawing 8] It is the I-I line sectional view of drawing 7 .
[Drawing 9] It is the T-T line sectional view of drawing 8 .
[Drawing 10] It is drawing showing the microwave field strength to the die length of the slot by the conventional example.
[Description of Notations]
1 1' Microwave power source
7 Plasma Room
7b Window part
18 18' Rectangular waveguide for plasma room association
18a, 18a' Eth page
18b, 18b' Slot
19 19' Termination machine
19c, 19c' Shorting bar

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